CHAPTER – II

REVIEW OF RELATED LITERATURE

A literature review is a body of text that aims to review the critical points of current knowledge, including substantive findings as well as theoretical and methodological contributions to a particular topic. Its ultimate goal is to bring the reader up to date with current literature on a topic and forms the basis for another goal, such as future research that may be needed in the area. It gives an overview of what has been said, who the key writers are, what are the prevailing theories and hypotheses, what questions are being asked, & what methods and methodologies are appropriate and useful. As such, it is not in itself primary research, but rather it reports on other findings.

The presentation reviews are based upon the available literature with respect to the study under investigation and therefore confined to the studies to which the investigator has accessed. All the relevant literature thus obtained by the researcher has been presented in this chapter to furnish necessary background material to evaluate the significance of the study.

The research scholar has made every possible effort to go through the literatures related to the problem in the submaximal and maximal training wherever available. The scholar has gleaned through almost every source like research quarterly, journals of various kinds, periodicals, encyclopedias, relevant book and e-resources. However,

the scholar has also gone through the literatures of allied studies to collect the necessary information for making a proper shape of the study. The reviews of the literature have been classified under the following headings.

1. Studies on submaximal and maximal aerobic training in musculoskeletal fitness
2. Studies on submaximal and maximal aerobic training on cardiopulmonary parameters.
3. Studies on smoking.
4. Summary of related literature.

2.1. STUDIES ON SUBMAXIMAL AND MAXIMAL AEROBIC TRAINING ON MUSCULOSKELETAL FITNESS.

Jibi Paul and Khairul Nizam bin Abdul Rahman, (2017) investigated the effects of physical exercise on cardiac endurance among smokers. This study was a Randomize Controlled Trial (R.C.T). Forty (40) subjects of smokers from KPJ Healthcare University College were selected for the study and randomly divided into two equal groups. The first 20 participants were in the experimental group, whereas the next 20 participants were in the control group. Harvard Step Test used to identify the cardiovascular endurance among the subjects before and after the exercise program. The experimental group was trained with the specific physical exercise program for 2 weeks, but the control group was not given any specific exercise during the period of study. Fitness Index Score used to measure the outcome of the subjects. The outcome of cardiac endurance improved

significantly in experimental group greater than the control group ($p<0.005$). The study concluded that physical exercise can improve cardiac endurance in smokers.

Zahra Hojati and Rajesh Kumar, et al., (2013) examined the effect of interval aerobic exercise on forced vital capacity in non-active female students. Forty healthy, non-active female students with no cardiovascular and pulmonary disease and skeletal deformity or smoking experience were randomly selected and divided into two groups; the experimental group (N=20) and control group (N=20). The experimental group performed 36 sessions of 45-minute interval aerobic running with 65-80% of heart rate reserve while the control group had no training program. Before beginning exercise plan and after 18th, 24th and 36th session of the training program, forced vital capacity (FVC) was evaluated by Lung Test1000 Spirometer. The results were analyzed by General Linear Model- Repeated Measures and the mean differences were tested. $P>0.05$ was considered as non-significant. The results showed that interval aerobic training had a significant effect on forced expiratory vital capacity (FVC EX) and forced inspiratory vital capacity (FVC IN) ($P<0.05$). It seems interval aerobic training programs can be used for improving female's cardio-respiratory function and its efficacy.

Ramesh and Subramaniam, (2010) conducted a study on the effect of aerobic and calisthenics exercise on health related physical fitness variables such as muscular strength, muscular

endurance, flexibility, cardio respiratory endurance and body mass index (BMI) of obese adolescents. Their age ranged from 12 to 18 years. They were divided into two groups and designed as the experimental group and control group. The Experimental group was given aerobic and calisthenics exercise for a period of three months, both morning and evening for five days in a week. However, the control group was not allowed to participate in aerobic and calisthenics exercise training programme. The result of this study indicated that muscular strength, muscular endurance, cardio respiratory endurance was significantly improved, and also it was observed that Body Mass Index significantly reduced.

Joav Merrick et al., (2013) examined the effect of treadmill walking on over-weight to obese females with unspecified mild intellectual disability (ID). Randomized assignment to an aerobic exercise group (G1, n = 6) and control group (G2, n = 3). The aerobic exercise group (G1) performed mild to moderate intensity walking for 25-45 minutes per exercise session, 3-5 times per week up to a weekly walking about 150 minutes, for 32 consecutive weeks. The control group (G2) maintained routine daily activities. The mean age of the study subjects was 57.2 ±7. 5 year, BMI was significantly decreased at the conclusion of the intervention (P = 0.005). In the aerobic exercise group (G1), the subcutaneous fat area was also significantly decreased (P = 0.005) but not in the control group (G2). No change was there in the visceral fat area of both groups. The quadriceps muscle's maximal

isometric muscle strength of the aerobic exercise group (G1) and control group (G2) did not change. Results identified long term mild to moderate intensity of aerobic physical exercise for over-weight to obese women with ID is a feasible and effective plan in reducing subcutaneous fat mass, while muscle strength remains unchanged.

Shahana, Usha and Hasrani, (2010) determined the effect of a 12-week aerobic exercise program for health-related physical fitness components, which are cardiorespiratory endurance, flexibility, abdominal strength endurance and body fat in middle-aged women. A total of 60 middle-aged women from Karyavattom panchayath of Trivandrum district in Kerala state between the age group of 35 and 45 years were selected as subjects for the study. They were tested to collect data on the selected variables. The cardiorespiratory endurance, flexibility, abdominal strength, endurance and body fat percentage were selected variables. Further, 30 subjects were randomly assigned as an experimental group and 30 as a control group. The experimental group underwent aerobic exercise training thrice a week for 12 weeks. The control group did not attend any training programme. The post-tests were conducted on both groups to collect the data on the variables of the study. The data pertaining to health-related physical fitness components were analyzed by paired't' test to determine the difference between initial and final mean for experimental and control groups. Significant difference seen at the 0.05 level with 29 degree of freedom is 2.045 and at 0.01 level with 29 degree of freedom is 2.756 in

experimental group following 12 weeks of aerobic training programme for cardiorespiratory endurance, flexibility, muscular strength endurance and skin fold thickness (body fat %). In the case of control group no significant changes were seen in any of the selected variables. The conclusions of this study, improve cardiorespiratory endurance, flexibility, muscular strength, endurance and decreased skin fold thickness (body fat %) among the experimental group of middle-aged women after 12 weeks of aerobic training.

Chia-Lin Li, et al., (2006) evaluated the effects of aerobic exercise intervention with goals of improving health-related physical fitness in one high-tech Company in Taiwan. This study was conducted as a quasi-experimental design. Among the 54 subjects enrolled in the study, 26 subjects of the volunteers agreed to participate in an aerobic exercise program. The control group was comprised of a similar sample of 28 subjects working at the same company. Subjects in the exercise group participated in a 12-week aerobic exercise program, while subjects in the control group did not participate. The results of analysis of variance with repeated measures of health-related physical fitness showed that the subjects in the exercise group had significantly more improvements in abdominal muscle strength and endurance than the subjects in the control group. This study indicated that one 12-week aerobic exercise program was effective in improving the abdominal muscle strength and endurance of employees of a high-tech company.

Mathewos Hosiso, Sangeeta Rani and Shemelis Rekoninne, (2013) investigated the effect of aerobic exercise on improving health related physical fitness components of sedentary female community. Twenty females from were selected as study subjects and their age range were 22-28 years. All Selected subjects were participated in moderate intensity aerobic exercise for 12 consecutive weeks, i.e.3 days per week 60 minute duration per day. Pre, during and post training, tests were conducted on the components of health related physical fitness variables. The data pertaining to health-related physical fitness components were analyzed by paired sample 't' test to determine the difference between initial and final mean for participant .According to analyzed data in 12 meter run 724.8 mean difference was recorded. The mean difference value boosted in push up performance by 5.4 after 12 weeks aerobic exercise. In sit up and sit and reach test 4.7 and4. 52 increments were observed respectively. But in body mass index 2.18 decrement and in body weight 5.8 reductions were observed throughout the study period. The result obtained in this study indicated that there was significant improvement in cardiovascular endurance, muscular endurance, muscular strength and flexibility, but in the case of body mass index and body weight there were reduced. Based on this finding, it can be concluded that Moderate aerobic exercise has a positive effect on improvement of health related physical fitness components of sedentary female communities.

Tsourlou, et.al., (2006) examined the effectiveness of a 24-week aquatic training (AT) program, which included both aerobic and resistance components, on muscle strength (isometric and dynamic), flexibility, and functional mobility in healthy women over 60 years of age. Twenty-two subjects were assigned randomly to either an AT (n = 12) or a control (C, n = 10) group. Volunteers participated in a supervised shallow-water exercise program for 60 minutes a day, 3 days a week; the exercise program consisted of a 10-minute warm-up and stretching, 25 minutes of endurance-type exercise (dancing) at 80% of heart rate (HR) (max), 20 minutes of upper- and lower-body resistance exercises with specialized water-resistance equipment, and a 5-minute cool down. Maximal isometric torque of knee extensors (KEXT) and knee flexors (KFLEX) were evaluated by a Cybex Norm dynamometer, grip strength (HGR) was evaluated using a Jamar hydraulic dynamometer, and dynamic strength was evaluated via the 3 repetition maximum (3RM) test for chest press, knee extension, lat pull down, and leg press. Jumping performance was evaluated using the squat jump (SJ), functional mobility with the timed up-and-go (TUG) test, and trunk flexion with the sit-and-reach test. Body composition was measured using the bioelectrical impedance method. The AT induced significant improvements in the KEXT (10.5%) and KFLEX (13.4%) peak torque, HGR strength (13%), 3RM (25.7-29.4%), SJ (24.6%), sit-and-reach (11.6%), and TUG (19.8%) performance. The AT group demonstrated a significant increase in lean body mass (3.4%). No significant changes in these variables

were observed in the C group. The results indicate that AT, with both aerobic and resistance components, is an alternative training method for improving neuromuscular and functional fitness performance in healthy elderly women.

Lewis, (2005) had conducted a study to determine the effects of a home exercise program of combined aerobic and strength training on fitness with a10. 5-year-old girl with Down syndrome (DS). Measurements included cardiovascular variables, strength, body composition, flexibility, and skill. The subject participated in a home exercise program: 30 to 60 minutes of moderate to high-intensity exercise five to six days per week for six weeks. The cardiovascular variables monitored were heart rate, respiration rate, and oxygen consumption during a submaximal treadmill stress test. Other measures included10-repetition maximal strength of selected muscle groups, body mass index, flexibility, Gross Motor Scales of the Bruininks-Oseretsky Test of Motor Proficiency, and anaerobic muscle power. Improvements in submaximal heart and respiration rates, aerobic performance, muscle strength and endurance, gross motor skills, and anaerobic power were observed in this subject. Body weight and flexibility were unchanged.

Kraemer, et.al., (2001) conducted a study of resistance training combined with bench-step aerobics which enhances women's health profile. Thirty-five healthy, active women were randomly assigned to one of four groups that either a) performed 25

min of BSA only (SA25); b) performed a combination of 25 min of BSA and a multiple-set upper and lower body resistance exercise program (SAR): c) performed 40 min of BSA only (SA40); or d) served as a control group (C) only performing activities of daily living. Direct assessments of body composition, aerobic fitness, muscular strength, endurance, power, and cross-sectional area were performed 1 week before and after 12 weeks of training. All training groups significantly improved peak VO (2) (3.7 to 5.3 ml 0 (2). kg (-l). min (-l)), with the greatest improvement observed in the SAR group (P =0.05). Significant reductions in pre exercise heart rates (8-9 bpm) and body fat percent (5—6%) were observed in all training groups after training. Significant reductions in resting diastolic blood pressure were observed in the SAR and SA 40 groups (6.7 and 5.8 mm Hg, respectively). Muscular strength and endurance only improved significantly in the SAR group (21 and 11% respectively). All groups demonstrated increased lower body power (11-14%), but only the SAR group significantly improved upper body power (32%). Thigh muscle cross-sectional areas measured via magnetic resonance imaging (MRI) increased primarily for the SAR group. BSA is an exercise modality effective for improving physical fitness and body composition in healthy women. The addition of resistance exercise appears to enhance the total fitness profile by improving muscular performances, muscle morphology, and cardiovascular fitness greater than from performing BSA alone.

Tsui-Er Lee, (2013) investigated the effects of a 12-week Aerobics and Exercise Perception course on Health-related Physical Fitness and Exercise Behavior of the middle-aged and elderly people. With purposeful sampling, total 38 middle-aged and elderly participants above the age 55 in a community are selected as the research samples for the tests of physical fitness and a questionnaire survey of Exercise Behavior before and after the intervention. The research outcomes show that (1) the blood pressure of male and female middle-aged and elderly participants achieves the significant difference ($p < .05$), (2) the cardiopulmonary, muscular, and flexibility fitness, but not BMI, in Health-related Physical Fitness reaches the significant difference ($p < .05$), and (3) the effects on Exercise Behavior do not achieve the significant difference ($p < .05$), but the exercise frequency, period, and item increase apparently; the variables of Exercise could assist in getting well with others, Exercise is funny, and Exercise could release pressure in Exercise Attitude reach the significant difference ($p < .05$) before and after the intervention; and, Exercise Perception merely achieves the significant difference ($p < .05$) on Perception of Aerobics. It is concluded that Aerobics and Exercise Perception course could improve Exercise Attitude of the middle-aged and elderly participants and enhance the cardiopulmonary, muscular, and flexibility fitness. For the improvement of body composition, intervention in exercise and diet control suitable for individuals should be planned so as to reduce weight and enhance health.

2.2 STUDIES ON SUBMAXIMAL AND MAXIMAL AEROBIC TRAINING ON CARDIOPULMONARY PARAMETERS

Abdul-Aziz Saied and Shahied, (2017) evaluated the effects of an interval exercise training program on pulmonary function and aerobic capacity in cigarette smokers. Twelve cigarette smokers and 11 non-smokers participated in our exercise program. All subjects performed 30 min of interval exercise (2 min of work followed by 1 min of rest) three times a week for 4 weeks at an intensity estimated at 70% of the subject's maximum aerobic capacity. Pulmonary function was measured using spirometry and maximum aerobic capacity was assessed by maximal exercise testing on a treadmill before the beginning and at the end of the exercise training program. As expected, prior to the exercise intervention, the cigarette smokers had significantly lower pulmonary function than the non-smokers. The 4-week exercise training program did not significantly affect lung function as assessed by spirometry in the non-smoker group. However, it significantly increased both forced expiratory volume in 1 second and peak expiratory flow (PEF) in the cigarette smoker group. Our training program had its most notable impact on the cardiopulmonary system of smokers. In the non-smoker and cigarette smoker groups, the training program significantly improved pulmonary capacity (4.4 and 4.7%, respectively). After 4 weeks of interval training program, the increase of VO2 max and the decrease of recovery index and resting heart rate in the smoking subjects indicated better exercise tolerance. Although the intermittent training

program altered pulmonary function only partially, both aerobic capacity and life quality were improved.

Samuel Sundar Doss and Rekha, (2016) examined the effects of Aerobic Exercise in Improving Cardio-Respiratory Fitness among Young Male Adult Smokers. Experimental Study was performed in 60 male subjects randomly allocated into 2 groups, Group A Experimental group and Group B Control group based on inclusion and exclusion criteria, Both the groups underwent pre test assessment their dyspnea level was graded using NYHA grading and they were assessed for spirometric variables such as FEV1, FVC, FEV1/FVC, and MVV. And their cardio-respiratory fitness was assessed using YMCA 3 minute step test. Group A was treated with Aerobic exercise for 4 times a week for a total period of 6 weeks and Group B subjects were treated with Diaphragmatic breathing exercises. At the end of 6 weeks both the groups were assessed for post test same as of pretest and results revealed that group A significantly improved in all variables compared to group B therefore study concludes that Aerobic exercise improved the cardio respiratory fitness among male adult smokers by improving FEV1, FVC, MVV and YMCA step test scoring and reduced dyspnea.

Ahmed, Mahmoud and Elnaggar, (2015) investigated the effect of aerobic training on lung functions in smoking university students. Forty-eight male smokers from Prince Sattam bin AbulAziz University students completed this study. Subjects were randomized into two

groups after fulfilling eligibility criteria, exercise group EG (n=23) or control group CG (n=25). EG subjects performed aerobic exercise for 12 weeks, 3 times weekly on non-consecutive days on a treadmill for 40 minutes at 65-80% of HRR. CG subjects didn't participate in the exercise program. Anthropometric measures, peak oxygen consumption (VO_2peak) and lung functions were assessed at baseline and after intervention. No significant differences were found between pre and post-test values of lung functions, VO_2peak or anthropometric measurements in CG. In EG, there were no significant differences between pre and post-test values of anthropometric parameters, lung functions except for MVV that showed significant increase ($p<0.05$) with a significant increase in VO2peak from36.6 ± 2.16 to 40.78 ± 2.27 [mL.min-1.kg-1].Also, there was a significant positive correlation between MVV and VO_2peakin EG. Aerobic exercise training should be included in the smoking management plans to improve aerobic capacity and to improve or at least to maintain lung functions in sedentary smokers.

Angane and Navare, (2016), evaluated the effects of aerobic exercise on pulmonary function tests in 65 healthy adult volunteers in age group of 20- 35 years. The same volunteers were chosen as both study as well as control group in order to minimize the confounding factors and make the study reproducible. The pulmonary function tests were carried out with a computerized spirometer medgraphics. The study revealed that the pulmonary functions are improved after

undergoing aerobic exercise training. Regular aerobic exercise is related to better cardiorespiratory efficiency and good pulmonary function. Higher lung volumes and flow rates were achieved in aerobic trainees after their training period, as compared to their own values obtained before their training period. The present study suggests that there is an improvement in pulmonary functions following aerobic exercise training. Hence regular physical activity causes many desirable physiological, psychological and physical changes in the individual.

Gormley, (2008) determined whether various intensities of aerobic training differentially affect aerobic capacity as well as resting HR and resting blood pressure (BP). Sixty-one health young adult subjects were matched for sex and VO_2max and were randomly assigned to a moderate- (50% VO_2 reserve (VO_2R), vigorous (75% VO_2R), near-maximal-intensity (95% VO_2R), or a non-exercising control group. Intensity during exercise was controlled by having the subjects maintain target HR based on HR reserve. Exercise volume (and thus energy expenditure) was controlled across the three training groups by varying duration and frequency. Fifty-five subjects completed a 6-wk training protocol on a stationary bicycle ergometer and pre- and post testing. During the final 4 wk, the moderate-intensity group exercised for 60 min, 4 d.wk the vigorous-intensity group exercised for 40 min, 4 d.wk and the near-maximal-intensity group exercised 3 d.wk performing 5 min at 75% VO_2R followed by five intervals of 5 min at 95% VO_2R and 5 min at 50% VO_2R. VO_2max

significantly increased in all exercising groups by 7.2, 4.8, and 3.4 mL.min.kg in the near-maximal-, the vigorous-, and the moderate-intensity groups, respectively. Percent increases in the near-maximal- (20.6%), the vigorous- (14.3%), and the moderate-intensity (10.0%) groups were all significantly different from each other ($P < 0.05$). There were no significant changes in resting HR and BP in any group. When volume of exercise is controlled, higher intensities of exercise are more effective for improving VO_2max than lower intensities of exercise in healthy, young adults.

Ganji, et al., (2012) compared the effects of one session of submaximal aerobic exercise and a maximal one on the prevalence of exercise-induced bronchospasm in non-athletic students. An experimental study, using human subjects, was designed. 20 non-athletic male students participated in two sessions of aerobic exercise. The prevalence of EIB was investigated among them. The criteria for assessing exercise-induced bronchospasm were ≥10% fall in FEV1, ≥15% fall in FEF25-75%, or ≥25% fall in PEFR. The results revealed that the maximal exercise did not affect FEF25- 75% and PEF, but it led to a meaningful reduction in FEV1. Contrarily, the submaximal exercise affected none of these indices. That is, in both protocols the same result was obtained for PEF and FEF25-75. Moreover, the prevalence of EIB was 15% in the submaximal exercise and 20% in the maximal one. Actually, this difference was significant. This study demonstrated that in contrast to the subjects who performed

submaximal exercise, those who participated in the maximal protocol showed more changes in the pulmonary function indices and the prevalence of EIB was greater among them**.**

Mughal, et al., (2001) examined the influence of 12-weeks aerobic exercise intervention (brisk walking) on resting systolic and diastolic blood pressure, pulse pressure, mean arterial blood pressure, body weight and body mass index in patients with essential hypertension. Twenty-seven men with stage 1 or 2 essential hypertension (not on antihypertensive medication) participated in the study. The aerobic exercise training protocol consisted of 30 minutes of brisk walking 3 to 5 times per week, at 50% of VO_2max on an ergometer cycle. The data were analyzed by comparing exercise responses at baseline and 12-weeks. Statically significant decrease in resting systolic and diastolic blood pressure were found ($p<0.05$). Reduced pulse pressure from baseline value of -3.7mmHg, ($p<0.01$) and mean arterial pressure of -3.4 mmHg ($p<0.01$) was noted. No discernible effects on mean body mass index was observed although mean body weights decreased -1.1kg, ($p<0.05$). Brisk walking exercise yielded significant increase in VO_2 max ($p<0.05$). Aerobic exercise caused small reduction in resting systolic and diastolic blood pressures in men with stage 1 or 2 essential hypertension. A lifestyle change such as exercising may play a role in reducing the risk of hypertension.

Anju Madan Gup, et al., (2015) conducted a study on effect of moderate Aerobic exercise training on pulmonary functions and its correlation with antioxidant status. 30 healthy volunteers in the age group of 18-22 years were screened. They underwent short term moderate aerobic exercise training. Various Pulmonary function tests including FVC, MVV & SVC were taken prior to aerobic exercise training and later after the exercise period. Antioxidant status was assessed by the level of malondialdehyde in plasma. FVC showed a significant increase while PEFR, IRV, MVV and MRF showed a highly significant increase after the aerobic exercise training. Physical exercise also provided a favourable change in the biochemical parameters such as MDA. It is concluded that indulgence in regular physical exercise can result in betterment of health in general and improvement in pulmonary functions and antioxidant status in particular.

Vitartaite, et al., (2004) evaluated the cardiovascular functional parameter changes for 30-40 year old women following the aerobics exercise program. The material consisted of 14 women, who participated in aerobics exercise 3 times per week (the average age 33.71+/-1.28 years). Arterial blood pressure measuring, electrocardiogram analysis and bicycle ergometry work were the methods used. System of ECG analysis "Kaunas-Krūvis" was used for the monitoring of cardiovascular system reactions. 12 ECG standard derivations were synchronically recorded. Physical work method of provocative incremental bicycle ergometry exercise was used. The

bicycle ergometry work was performed applying 50 W intensity in the beginning and increasing the power every minute by 25 W. The following functional parameters were estimated in this study: heart rate, arterial blood pressure, JT interval, ST segment depression at rest and in each level of functional load. It was established that heart beat rate of participants statistically in each level of functional load after one year of regular aerobics exercise significantly decreased ($p<0.05$) at rest and Although JT interval values of participating women were higher during the second examination than during the first one, only in one level of functional load (at 75 W power) there was statistically significant ($p<0.05$) increase of this parameter. Statistically significant decrease ($p<0.05$) at 50 W and 75 W intensity of ST segment depression was observed in the examination. The systolic blood pressure of women, who were engaged in the aerobics exercise, did not change; the diastolic blood pressure statistically significantly decreased ($p<0.05$), when participant achieved 75 W and 100 W intensity. Aerobics exercise is the proper physical activity form for 30-40 year old women for the developing of cardiovascular functional parameters.

Chaitra, et al., (2012) evaluated the effect of aerobic exercise training on pulmonary function tests in healthy young men. We recruited twenty; apparently healthy male medical students aged 17-20 years. The subjects participated in a 16 weeks aerobic exercise plan. Pulmonary function test was recorded before the commencement

of training and at the end of training. The data were analyzed by paired 't' test. P< 0.05 was considered significant. After the training there was significant improvement in pulmonary function tests (P < 0.05). In conclusion, the current study has shown that, there is significant positive relationship between aerobics training and pulmonary function in healthy young men.

Ahmad Azad, et al., (2013) evaluated the effect of aerobic exercise training on improving lung function in overweight and obese students. Thirty overweight or obese subjects with poor endurance performance and mild deterioration of respiratory indices (forced expiratory volume and forced expiratory volume in 1 second < 90% predicted) were randomly assigned into control (age: 16.6±0.83 years, height: 167±5.05 cm, weight: 80.44±7.65 kg) and intervention groups (age: 16.5±0.83 years, height: 166±6.7 cm, weight: 79.62±9.33 kg). The intervention group preformed 24 weeks of continuous treadmill running (3 days a week). Respiratory indices were measured pre, mid and post exercise. Independent t test, paired t test, Pearson's correlation test and repeated measure were used for analyzing the data. In the intervention group, post exercise respiratory indices were significantly higher than the pre exercise values, and did not reach the predicted values. No significant differences were found in pre, mid and post exercise respiratory indices in the control group. In the intervention group, improvements in respiratory indices were positively correlated with maximum voluntary ventilation (MVV) improvement but

not with BMI reduction. No significant differences were detected between the 2 groups in terms of pre, mid and post exercise measures of BMI, weight, height, and respiratory indices. In overweight and obese teenagers, appropriate aerobic exercise training can partly improve lung function by strengthening the muscles of respiration. However, in order to achieve the predicted values of lung function, a further increase in activity duration and decrease in BMI is necessary.

Egana and Donne, (2004), investigated the metabolic and cardiorespiratory improvements following a 12-week aerobic training program using elliptical trainer, treadmill or stair-climbing modalities. Twenty-two moderately active females (28.6 +/- 5.3 y, 1.65 +/- 0.05 m) were randomly assigned to treadmill running (n=7), elliptical trainer (n=8) or stair-climber (n=7) groups and trained 3 days x week(-1) initially at 70-80% of maximum heart rate (HRmax) for 30 min, progressing to 80-90% HRmax for 40 min. Subjects performed incremental exercise to volitional exhaustion using an electronically loaded cycle ergometer before and upon completion of the program. In addition, subjects performed sub-maximal fixed load tests at 0, 4, 8 and 12 weeks, using ergometers specific to their exercise group. No significant inter-group differences were recorded for pre-training VO_2max or VEmax. Significant ($p<0.05$) post-training increases in cycling VO_2max and VEmax were observed for treadmill (mean +/- SEM, 40.7 +/- 2.2 vs 43.4 +/- 2.6 ml x kg(-1) x min(-1) and 82.9 +/- 5.1 vs 90.2 +/- 6.4 l x min(-1)), elliptical trainer (36.9 +/- 2.5 vs 39.6

+/- 2.4 ml x kg(-1) x min(-1) and 86.8 +/- 2.3 vs 92.5 +/- 4.1 l x min(-1)) and stair-climber (37.4 +/- 2.9 vs 39.2 +/- 3.1 ml x kg(-1) x min(-1) and 95.9 +/- 5.8 vs 97.4 +/- 5.8 l x min(-1)) modalities, however, the increases were not significantly different between groups. For all groups, sub-maximal HR significantly decreased from week 0 to 4, and from week 4 to 8. In moderately active females similar physiological improvements were observed using stair-climber, elliptical trainer and treadmill running when training volume and intensity were equivalent.

Joubert, et al., (2011) examined the effects of elliptical cross training on VO_2max in recently trained runners. 12 female and 8 male participants (mean Â± SD; age = 23.70 Â± 6.33 years, body mass index = 24.85 Â± 5.89 kg/mÂ²) completed an initial four-week run training program, exercising four days/week, 30 minutes/day, at 80% maximal heart rate. VO_2max was predicted based on the duration of a Bruce graded-maximal treadmill test (GXT) prior to and after the run training. After initial training phase and post-test, subjects volunteered for the detrain group (n = 6) or were assigned to the run (n = 7) or elliptical (n = 7) based on a matched pair design. Elliptical and run groups exercised three weeks under same prescription as initial program. GXT again performed after mode-specific training phase. VO_2max (ml/kg/min) increased ($p < 0.001$) from the pre-training (39.89 Â± 10.74) to post-training (41.66 Â± 10.90) after the initial run training program. Although not statistically

significant, VO_2max declined (0.8% running, 1.5% elliptical, and 4.8% detraining) for all groups following the additional mode specific program. Despite declines, repeated measures ANOVA showed no significant differences within or between groups before and after the mode-specific training phase. However, dependent sample t-test did reveal a decline ($p < 0.05$) in GXT time (minutes) for the detrain group from before (11.01 Â± 2.80) and after (10.54 Â± 2.72) their detrain phase. Future research should determine if elliptical exercise maintains VO_2max when away from running for longer periods.

Ashira Hiruntrakul, et al., (2010) conducted a study whether 3-months aerobic exercise training at moderate intensity once a week can increase fitness status in healthy sedentary young men. Randomized controlled study was performed in 37 sedentary young men, 18 to 25 years old. The exercise group (19) was assigned to work on bicycle ergometry at 60% of maximal effort, once a week for 12 weeks. The control group (18) lived a normal life style. Before and after training, aerobic fitness (VO_2max), resting heart rate, lipid profile, and isokinetic power and strength of shoulder and knee were evaluated. In the exercise group, there was a significant increase in most fitness parameters compared with control, VO_2max (19.7%), isokinetic power and strength of shoulder and knee (14.9%), and resting heart rate decreased (7.4%). Moderate-intensity training once a week for at least 12 weeks was sufficient to increase aerobic fitness in sedentary young men.

Murugavel and Logeswaran, (2014) assessed the changes over vo_2 max, resting pulse rate, cardio respiratory endurance and breath holding time by utilizing aerobic dance with different impacts and frequencies. One hundred and twenty males aged between 18 and 24 years served as subjects for test validation. The subjects completed a treadmill test to determine VO_2 max and were assessed for heart rate (HR) response to a bout of aerobic dance. The experimental design used in this study was 2×2 factorial design involving 120 subjects; the study consisted of four experimental groups. Prior to and after exercise changes over Vo2 max, resting Pulse rate, cardiorespiratory endurance and breath holding time were assessed for a period of 12 weeks of aerobic dance in different impacts and frequencies. Pre and post experimental baseline testing were also performed. Bench step and Astrand nomogram, bio monitor, cooper's 12 minutes run and walk and breath holding test were used to assess Vo2 max, resting pulse rate, cardiorespiratory endurance and breathe holding time respectively. Data analysis was conducted using two way analysis of variance and 'F' test. Significant changes were observed over vo2 max, resting pulse rate, cardiorespiratory endurance and breathe holding time due to implemented aerobic dance programme for a period of 12 weeks. Further low impact aerobic dance training for 5 days per week (LIA5DT) produced better changes over vo2 max (0.971 l/kg/ml), resting pulse rate (4.87 B/Min), cardio respiratory endurance (197m), breath holding time (5.23 secs) than LIA3DT, HIA3DT and HIA5DT. This study demonstrated that the low impact aerobic dance training for

more number of days a week is a suitable training modality to bring out desirable changes over physiological variables of college men.

Parameswari and Elayaraja, (2010) evaluated the effects of intensive and extensive interval training on selected physiological parameters. Forty five men students age between 18 and 24 were randomly selected and they were divided into three equal groups (n = 15) namely intensive interval training group (IITG), extensive interval training group (EITG) and control group (CG). The IITG and EITG group were underwent their respective training programme for three days per week for twelve weeks in which the CG did not participate any special training programme apart from their regular physical education activities as per their curriculum. Physiological variables namely cardio respiratory endurance and breath holding time were selected as criterion variables. All the subjects of three groups were tested on selected dependent variables at prior to and immediately after the training programme. The analysis of covariance (ANCOVA) was used to analyze the significant difference, if any among the groups. Since, three groups were compared, whenever the obtained 'f' ratio for adjusted post test was found to be significant, the Scheffe's test was used to find out the paired mean differences, if any. The result showed that there was a significant mean difference exists among intensive interval training group (IITG), extensive interval training group (EITG) and control group (CG) on cardio respiratory endurance and breath holding time.

However, the improvement on cardio respiratory endurance and breath holding time were greater in EITG than in IITG.

Daljeet Singh and Monika Verma, (2014), assessed the effect of Aerobic exercise on physiological variables of rural background sports men. The study concluded that 15 week training of aerobic exercise had a positive effect on Body weight, heart rate, hemoglobin, breath hold capacity and blood pressure of rural background sports men. The aerobic exercise reduces the level of Body weight, heart rate, blood pressure and also enhanced the level of breath hold capacity & hemoglobin in blood.

Sinku, (2012) examined the effects of health related physical fitness programmes that are covered in the academic programme of physical education department on the cardio respiratory functions of sedentary students. Fifteen sedentary male students studying in different colleges of the Swami Raman and Teerth Marathwada University Nanded, Maharashtra, India volunteered to be the subjects for the study. The mean age, height and weight of these students were 20.3+2.66 years, 172.33+5.99 cm. and 69.29+4.01kg respectively. Resting heart rate, vital capacity, breath holding capacity after expiration and inspiration and respiratory rate were recorded at the begging of 2009-2010 academic year in this study on all the subjects. The health related physical fitness programme was administered for twelve weeks, 5 days a week and for

120 minutes a day. Mean scores and standard division were take and paired t-test was applied. A significant effect on resting heart rate (t=4.44, p<0.05) respiratory rate (t=4.15, p=0<.05) and vital capacity (t=4.30, p=0<.05) was observed. However no significant effects on breath holding capacity after expiration (t=0.07) & breath holding capacity after inspiration (t=0.72) was observed. In the study it was found that twelve weeks of health related physical fitness programme resulted in a significant decrease in the resting heart rate and respiratory rate with significant increase in the vital capacity. According to the results it can be concluded that diet and health related physical fitness programme in physical education department is not only beneficial to increase the cardio respiratory functions and improve physical fitness of sedentary students but also improve the cardio respiratory functions of players of various sports disciplines and general people. The study provides a platform for further research in the field of physical education.

Sivagnanam and Elango, (2010) analyzed the effect of walking and aerobic training on cardiorespiratory endurance. Sixty middle aged men were selected as subject at random and their age was between 35 and 45 years, they divided into three groups namely walking training group (N = 20), aerobic training group (N = 20) and control group (N = 20). The data were collected on the selected variable before and after the training programme. The training period was limited to twelve weeks with the three alternative days per week. The

collected data were analyzed by using Analysis of Covariance and it revealed that the statistically significant differences were found towards the experimental and control groups. The favoring was towards aerobic training group at programme was more effective than walking training group on cardiorespiratory endurance.

Sinku, (2012) examined the effects of health related physical fitness programmes that are covered in the academic programme of physical education department on the cardio respiratory functions of sedentary students. Fifteen sedentary male students studying in different colleges of the Swami Ramanand Teerth Marathwada University Nanded, Maharashtra, India volunteered to be the subjects for the study. The mean age, height and weight of these students were 20.3+2.66 years, 172.33+5.99 cm. and 69.29+4.01kg respectively. Resting heart rate, vital capacity, breath holding capacity after expiration and inspiration and respiratory rate were recorded at the begging of 2009-2010 academic year in this study on all the subjects. The health related physical fitness programme was administered for twelve weeks, 5 days a week and for 120 minutes a day. Mean scores and standard division were take and paired t-test was applied. A significant effect on resting heart rate ($t=4.44$, $p<0.05$) respiratory rate ($t=4.15$, $p=0<.05$) and vital capacity ($t=4.30$, $p=0<.05$) was observed. However no significant effects on breath holding capacity after expiration ($t=0.07$) & breath holding capacity after inspiration ($t=0.72$) was observed. In the study it was found that twelve weeks of health

related physical fitness programme resulted in a significant decrease in the resting heart rate and respiratory rate with significant increase in the vital capacity. According to the results it can be concluded that diet and health related physical fitness programme in physical education department is not only beneficial to increase the cardio respiratory functions and improve physical fitness of sedentary students but also improve the cardio respiratory functions of players of various sports disciplines and general people.

Milena Mikalacki, Nebojsa Cokorilo and Pedro Jesus Ruiz-Montero, (2017) compared the differences of a Pilates-Aerobic intervention program on physiologic parameters such as the maximum heart rate (HRmax), relative maximal oxygen consumption (relative VO_2max) and absolute (absolute VOmax), maximum heart rate during maximal oxygen consumption (VO_2max-HRmax), maximum minute volume (VE) and forced vital capacity (FVC), a total of 64 adult women (active group = 48.1} 6.7 years; control group = 47.2} 7.4 years) participated in the study. The physiological parameters, the maximal speed and total duration of test were measured by maximum exercise capacity testing through Bruce protocol. Pulmonary function tests, maximal speed and total time during the physical test were performed in a treadmill (Medisoft, model 870c). The spirometry analyzed the impact on oxygen uptake parameters, including FVC and VE. The VO_2max (relative and absolute), VE (all, $P<0.001$), VO_2max-HRmax ($P<0.05$) and maximal

speed of treadmill test (P<0.001) showed significant difference in the active group after a physical exercise interventional program. The present study indicates that the Pilates exercises through a continuous training program might significantly improve the cardiovascular system.

Siroos Hosseini Askarabadi, Rohollah Valizadeh and FatemeDaraei, (2012) conducted a study on the effects aerobic exercise on some pulmonary indexes, body composition, body fat distribution and VO_2max in normal and fat men of personal and members of faculty of Azad university Bebahan branch. There are several reports on the association between body mass index (BMI) and pulmonary indexes. Body fat distribution and overweight are generally inactive and are with decreased working potential for them , the amount of energy they need for daily activities is consumed by energizing the respiratory organs due to the depression in the pulmonary operation and weakness of respiratory organs. The method of this study was per-tested and post-tested with the control group .Statistical sample of this research, includes 200 of male masters and personnel of Behbahan Azad University with average between 35 to 45 ages. In this study, the examinees were categorized by simple random selection into experimental groups of less than -25, and more than 25 BMI. Before the exercises aerobics we took pre-test and post-tested of pulmonary indices (FEV1, FVC), body mass index, body fat distribution and VO_2max from each group, and obtained data are

analyzed by ANACOVA, and analyzing of data is done by SPSS software. The result of this study has shown that aerobic exercise has affected on pulmonary indices, BMI, VO_2max and body fat distribution in fat and normal groups and there were significant difference s between these groups and control groups P 0≤05. There are many studies have shown the effect of aerobic training on pulmonary indices, BMI, VO_2max. We can see a positive significant associated between VO_2max and pulmonary indices and a negative significant associated between pulmonary indices and BMI, body fat distribution with increase in once caused decrease in another.

Mohammad Hassan Ferdowsia, et al., (2011) investigated the effects of eight week aerobic exercises on some of airway trachea indexes (FEV1, FVC, FEV1.FVC & FEF25-75) and VO_2max level in overweighed Male Students of Ahwaz Payam Noor University. For this reason we use male college students (n=40) and (age 21.06±3 years old, length 171.20±7 CM, weight 82.06±7 Kg, body mass index 26.04± 1 Kg.M2) as research sample who did not do any sport. Then was measured the VO_2max level by sub maximal incremental Bruce test on treadmill. Also the airway trachea indexes (FEV1, FVC, FEV1.FVC & FEF25-75) were measured by digital spirometer. All of subjects followed the aerobic exercise protocol for 8-week and 3 sessions in a week as 70 to 85 percent of HRR. Data analyzed by independent test(t-test) method at p value(p=0.05) revealed that 8-week aerobic exercises with 70 to 85

percent of HRR related to significant enhancement in airway trachea indexes (FEV1,FVC,FEV1.FVC & FEF25-75) and VO_2max level.

Davar Rezaimanesh and Parisa Amiri-Farsani, (2011) conducted with a semi-experimental design. All the male athlete students of the Khorramshahr Marine Science and Technology University make up the Statistical population (N=168) from which 30 subjects were randomly chose and again, randomly divided, in to 2 equal groups, each 15 (group1: aerobic, group2: anaerobic). The smirnov-kolmogorov test, the independent t-test and the dependant t-test were used to test the hypotheses (α=0.05). The results showed a meaningful relationship both between the six-week anaerobic intermittent exercises and VO_2max, IRV, ERV and between the six-week aerobic intermittent exercises and VO_2max, IRV, ERV, VC, TLC. According to the results of this study, a six-week aerobic and anaerobic intermittent swimming had significant effect on VO_2max and some lung volumes and capacities in student athletes.

Mackay, (2012) conducted a study whether high-intensity aerobic treadmill exercise improve cardiovascular fitness and gait function in people with chronic stroke. It is a Randomized, controlled trial. Individuals with chronic stroke >60 years of age with residual gait impairment, and ability to walk on the treadmill at ≥0.3km/h for 3 minutes were eligible. Serious cardiovascular conditions (eg, angina pectoris, heart failure, valvular dysfunction, peripheral arterial occlusive disease), dementia, aphasia, and major depression were

exclusion criteria. Randomisation of 38 participants allocated 20 to the intervention group and 18 to the usual care group. The intervention group underwent treadmill training (3 times/week) for 3 months. The program was intended to achieve 30-50 minutes of treadmill training at 60-80% of the maximum heart rate reserve as determined by a maximum effort exercise test. The training was supervised by a physician and/or physiotherapist. The usual care group received conventional care physiotherapy for 1 hour 1-3 times a week without any aerobic training. The primary outcomes were peak oxygen consumption rate and the 6-minute walk test. Secondary outcome measures were self-selected and maximum walking speeds as measured in the 10-m walk test, Berg balance score, 5-Chair-Rise test, Rivermead Mobility Index, and Medical Outcomes Study Short-Form 12 (SF- 12). The outcomes were measured at baseline, immediately after completion of training, and at 12 months. 36 participants completed the study. After the 3-month training period, the change in peak oxygen consumption rate was significantly more in the treatment group, by 63mL/kg/min (95% CI 57 to 69). The change in distance achieved in the 6-minute walk test was also significantly more in the treatment group by 53 metres (95% CI 32 to 75). Among the secondary outcomes, maximum walking speed (by 0.14m/s, 95% CI 0.08 to 0.20), Berg balance score (by 2.6 points, 95% CI 0.5 to 4.7), and SF-12 Mental score (by 4.0 points, 95% CI 3.4 to 4.6) improved significantly more in the treadmill training group than the usual care group after the treatment period. The groups did not differ

significantly on the remaining secondary outcomes. It was reported that compared to baseline peak oxygen consumption rate and 6-minute walk test distance were significantly improved at 12 months. A high-intensity treadmill training program improves cardiovascular fitness and gait in older adults with chronic stroke.

Moradichaleshtori, Salami, and Jafari, (2008) assessed the effects of amount of ergometer cycle training on VO_2max and body composition in overweight women. Forty-one sedentary premenopausal women, age 25 to 45 years, were randomly assigned in three groups. Cycle ergometer training consisted of one day per week for group a, two days per week for group B and three days per week for group C. Participants trained for 60 min in any session with moderate intensity (50-60% Vo_2max) for 12 weeks. Participants were counseled not to change their diet during the study period. There were no significant differences among variables in three groups at baseline. Means (±SD) of weight, body fat, WHR, BMI and VO_2max in groups were 67.43±9.54kg, 31.56±4.6 percent, 0.82±0.05, and 25.54±4.16 kg/m2 and 31.72±7.2 ml.kg-1 min-1 respectively. After 12 weeks, ANOVA test indicated there were significant differences among mean body composition among the three groups. Use of Tukey post-hoc tests showed that difference in these groups is because of group C. Paired 't' test showed that there was significant difference between mean body composition ($p<0.01$) in group C. Vo_2max in group B and C improved 12% and 21% ($p<0.01$)

respectively with ergometer training. But in group it was not changed significantly. These findings indicate that the three days in week with 60 min of moderate-intensity, cycle ergometer training is sufficient to improve body composition and VO_2max in overweight women. With two days training i.e. 120 min in a week only, VO_2max improved. The results indicate that two days regular training improves VO_2max in overweight women without change in body composition. With less of amount of physical activity neither body composition nor Vo_2max improve significantly. These findings strongly suggest that, in the absence of changes in diet, a higher amount of activity is necessary for improving body composition and Vo_2max.

Mctiernan, et al., (2007) examined the exercise effect on weight and d female children than in their adolescent counterparts of both training groups. Body composition in men (N = 102) and women (N = 100). Sedentary/unfit persons, 40 to 75 years old, were recruited through physician practices and media. The intervention was facility- and home-based moderate-to-vigorous intensity aerobic activity, 60 min/d, 6 days/wk vs. controls (no intervention). Exercisers exercised a mean 370 min/wk (men) and 295 min/wk (women), and seven dropped the intervention. Exercisers lost weight (women, -1.4 vs. -0.7 kg in controls, p = 0.008; men, -1.8 vs. -0.1 kg in controls, p =0.03), BMI (women, -0.6 vs. -0.3 kg/m2 in controls, p = 0.006; men, -0.5 kg/m2 vs. no change in controls, p =0.03), waist circumference (women, -1.4 vs. -2.2 cm in controls, p < 0.001; men, -3.3 vs. -0.4 cm

in controls, p = 0.003), and total fat mass (women, -1.9 vs. -0.2 kg in controls, p < 0.001; men, -3.0 vs. -0.2 kg in controls, p< 0.001). Exercisers with greater increases in pedometer-measured steps per day had greater decreases in weight, BMI, body fat, and intra-abdominal fat (all p trend < 0.05 in both men and women). Similar trends were observed for increased minutes per day of exercise and for increases in maximal oxygen consumption.

Harsoda and Geetanjali Purohit, (2013) conducted a study on the effect of whole body exercise, walking exercise, upper and lower limb exercise and combined exercise on sedentary males. Seventy five healthy non-smoking males aged between 15-25 years were recruited for 12 week exercise training. Participants were divided into five groups, 15 in each. Each group performed different exercise for 12 weeks under the supervision of physical trainer. Interventions included respiratory rate, resting pulse rate, blood pressure, forced expiratory volume in one second (FEV1), peak expiratory flow rate (PEFR), 6 minute walk distance (6 MWD), 12 minute walk distance (12 MWD), 6 minute bicycle ergometer (6 MBE) test and 6 minute arm ergometer (6MAE) test. Parameters were studied twice before and after exercise training. Data was represented as mean±SD. Students paired t test was applied for pre and post data analysis. The increase in cardiorespiratory efficiency was found significantly higher in response to whole body, combined and walking exercise. The other mode like only upper limb or lower limb exercises are not as beneficial. In

conclusion cardio-respiratory efficiency and exercise performance both are improved by regular exercise training and whole body exercise is the best among all. Lower limb exercise is least beneficial.

Cheng, et al., (2003) examined the role of physical activity in maintaining cardiac and respiratory function in healthy people. Cardiorespiratory fitness was measured by a maximal treadmill test (MTT), and respiratory function was tested by spirometry. The cross sectional study included data from 24 536 healthy persons who were examined at the Cooper Clinic between 1971 and 1995; the longitudinal study included data from 5707 healthy persons who had an initial visit between 1971 and 1995 and a subsequent visit during the next five years. All participants were aged 25–55 years and completed a cardiorespiratory test and a medical questionnaire. In the cross sectional study, after controlling for covariates, being active and not being a recent smoker were associated with better cardiorespiratory fitness and respiratory function in both men and women. In the follow up study, persons who remained or became active had better MTT than persons who remained or became sedentary. Men who remained active had higher forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) than the other groups. Smoking was related to lower cardiorespiratory fitness and respiratory function. Physical activity and non-smoking or smoking cessation is associated with maintenance of cardiorespiratory fitness.

2.3 STUDIES ON SMOKING

George Papathanasiou, et al., (2013) examined the effects of smoking on resting heart rate and on heart rate responses during and after exercise in young adults. A sample of 298 young adults (159 men), aged 20-29 years old, were selected from a large population of health-science students based on health status, body mass index, physical activity, and smoking habit. All subjects underwent a maximal Bruce treadmill test and their HR was recorded during, at peak, and after termination of exercise. Smokers had significantly higher resting HR values than non-smokers. Both female and male smokers showed a significantly slower HR increase during exercise. Female smokers failed to reach their age-predicted maximum HR by 6.0 bpm and males by 3.6 bpm. The actual maximum HR achieved (HRmax) was significantly lower for both female smokers (191.0 bpm vs.198.0 bpm) and male smokers (193.2 bpm vs.199.3 bpm), compared to non-smokers. Heart rate reserve was also significantly lower in female (114.6 bpm vs. 128.1 bpm) and male smokers (120.4 bpm vs. 133.0 bpm). During recovery, the HR decline was significantly attenuated, but only in female smokers. Females had a higher resting HR and showed a higher HR response during sub-maximal exercise compared to males. Smoking was found to affect young smokers' HR, increasing HR at rest, slowing HR increase during exercise and impairing their ability to reach the age-predicted HRmax. In addition, smoking was associated with an attenuated HR decline during recovery, but only in females.

Abdessalem Koubaa, et al., (2013) examine the effect of physical activity after 16 weeks training, on life quality and cardiorespiratory responses through the 6 min walking test in sedentary adult smokers. Sixty five sedentary smokers and non-smokers participated in this study. They consider cigarettes smokers; all subjects who consumed greater than or equal to 10 pack-years (PA). A MWT was performed, pre-and post-training program. The subjects were divided into 2 equal groups. The first cigarette smokers group (SG) and the second non-smokers group (NSG). The two groups were subjected to a drive period of 16 weeks. A significant decrease in dyspnoea similar to the resting HR and systolic BP (SBP) ($p < 0.01$ and $p < 0.05$ respectively). For smokers group, resting HR and SBP are significantly higher than those of non-smokers at the beginning and end of the study ($p<0.001$). Similarly, they recorded in these groups lowered values of diastolic BP (DBP) but is significant only for subjects SG ($p < 0.05$). Cigarette smokers showed a decrease in Max HR (beats. min-1) at the end of the protocol (142.2 ± 2.9 before vs. 138.3 ± 1.2 after), significantly higher than non-smokers (138.9 ± 1.7 pre-test vs. 137.7 ± 1.2 post-test). Oxygen saturation (O_2.S), both groups' cigarettes smokers and non-smokers are homogeneous at the beginning and the end of the study revealed no significant difference. Important changes in the body tolerance at exercise in sedentary adult smokers undergo a training program for 4 months. This program is to provide alternatives several for reducing tobacco.

Lee and Chang, (2013) investigated the effects of cigarette smoking on maximal aerobic capacity, anaerobic capacity, and heart rate variability among female university students. Twelve smokers and 21 non-smokers participated in this study. All participants performed an intermittent sprint test (IST) and a 20 m shuttle run test to measure their anaerobic capacity and maximal aerobic capacity. The IST was comprised of 6 × 10-second sprints with a 60-second active recovery between each sprint. Heart rate variability was recorded while the participants were in a supine position 20 minutes before and 30 minutes after the IST. The total work, peak power, and heart rate of the smokers and non-smokers did not differ significantly. However, the smokers' average power declined significantly during sprints 4 to 6 (smokers versus non-smokers, respectively: 95% confidence interval =6.2–7.2 joule/kg versus 6.8–7.6 joule/kg; $P<0.05$), and their fatigue index increased (smokers versus non-smokers, respectively: 35.8% ± 2.3% versus 24.5% ± 1.76%; $P<0.05$) during the IST. The maximal oxygen uptake of non-smokers was significantly higher than that of the smokers ($P<0.05$). The standard deviation of the normal to normal intervals and the root mean square successive difference did not differ significantly between non-smokers and smokers. However, the non-smokers exhibited a significantly higher normalized high frequency (HF), and significantly lower normalized low frequency (LF), LF/HF ratio, and natural logarithm of the LF/HF when compared with those of the smokers ($P<0.05$). Smoking may increase female

smokers' exercise fatigue and decrease their average performance during an IST, while reducing their maximal aerobic capacity. Furthermore, smoking reduces parasympathetic nerve activity and activates sympathetic cardiac control.

Barboza, et al., (2016) determined whether the level of physical activity in daily life (PADL) is associated with pulmonary function in adult smokers. We selected 62 adult smokers from among the participants of an epidemiological study conducted in the city of Santos, Brazil. The subjects underwent forced spirometry for pulmonary function assessment. The level of PADL was assessed by the International Physical Activity Questionnaire and triaxial accelerometry, the device being used for seven days. The minimum level of PADL, in terms of quantity and intensity, was defined as 150 min/week of moderate to vigorous physical activity. Correlations between the studied variables were tested with Pearson's or Spearman's correlation coefficient, depending on the distribution of the variables. We used linear multiple regression in order to analyze the influence of PADL on the spirometric variables. The level of significance was set at 5%. Evaluating all predictors, corrected for confounding factors, and using pulmonary function data as outcome variables, they found no significant associations between physical inactivity, as determined by accelerometry, and spirometric indices. The values for FVC were lower among the participants with arterial hypertension, and FEV1/FVC ratios were lower among those with

diabetes mellitus. Obese participants and those with dyslipidemia presented with lower values for FVC and FEV1. Our results suggest that there is no consistent association between physical inactivity and pulmonary function in adult smokers. Smoking history should be given special attention in COPD prevention strategies, as should cardiovascular and metabolic co-morbidities.

Tzani, et al., (2008) assessed maximal exercise capacity and its relationship with lung function in apparently healthy smokers. We recruited 15 heavy smokers (age 47 years ± 7, BMI 25 kg/m2 ± 3, pack/years 32 ± 9) without any cardiovascular or pulmonary signs and symptoms. Fifteen healthy non-smoking subjects were enrolled as a control group. All subjects underwent pulmonary function tests, electrocardiograms at rest and graded cycle exercise tests. In smokers and controls, resting lung and cardiac function parameters were in the normal range, apart from diffusing lung capacity (TLCO) values which were significantly lower in smokers ($p < 0.05$). As compared to controls, smokers presented lower maximal exercise capacity with lower values at peak of exercise of oxygen uptake (peak VO_2), workload, oxygen uptake/watt ratio and oxygen pulse ($p < 0.05$) and higher dyspnoea perception ($p < 0.05$). Moreover, peak VO_2, maximal workload and oxygen pulse at peak exercise were related to and predicted by TLCO ($p < 0.05$). Our study confirms that maximal exercise capacity is reduced in apparently healthy heavy smokers, and shows that TLCO explains some of the variance in maximal exercise.

Kobayashi, et al., (2004) examined the effects of habitual cigarette smoking on cardiorespiratory responses to sub-maximal and maximal works were evaluated in nine adult non-smokers and nine smokers with a mean age of 33 yr. A maximal treadmill test was followed by three tests at 45, 60 and 75% of each subject's VO_2max. Compared to non-smokers, the habitual smokers had a non-significantly lower VO_2max in L/min and per lean body mass (9 and 6%, respectively), but had higher %fat ($p<0.01$), resulting in a significantly lower VO_2max per kg body wt (13%, $p<0.03$). Maximal exercise ventilation (VE) was 16% lower in smokers. During sub-maximal work at equivalent exercise stress levels in the two groups, the VE/VO_2 ratio was higher in smokers by an average of 11% because VO_2 was lower and the respiratory exchange ratio values were significantly elevated in smokers at 75% of VO_2max. Blood lactate concentrations in smokers were higher as workloads increased and O_2 pulse (VO_2/HR) was significantly lower throughout, indicating reduced O_2 extraction, probably due to carbon monoxide. The resting HR was significantly higher in smokers and the HR recovery following all three submaximal exercises was significantly slower in smokers. These results show that detrimental cardiorespiratory effects of chronic cigarette smoking in apparently healthy individuals are evident at moderate exercise levels as reduced gas exchange efficiency in lungs and muscles.

Kwang Suk, et al., (2015) investigated the HRR rate after exercise according to smoking status in healthy college male students

who regularly exercised. Participants were categorized into either a non-smoker group (n = 24) or a smoker group (n = 19). Those who had been smoking 10 cigarettes per day for more than 5 years were categorized as smokers. The mean ± standard deviation age of the patients in the non-smoker and smoker groups were 20.5 ± 2.7 and 21.5 ± 2.3 years, respectively, without any significant difference ($t = -0.874$, $P = 0.393$). The participants in this study were healthy people who regularly exercised at least 3 times a week and had no history of disease or cardiac malfunction (dysfunction) on resting electrocardiography. In a treadmill exercise test (graded exercise test) using the Bruce protocol, VO_2max (mL·kg·min) and heart rate (bpm) were determined. HRR was assessed at 20 (HRR, 20), 40 (HRR, 40), 60 (HRR, 60), and 80 seconds (HRR, 80) after exercise. Decreasing heart rate (%) was calculated by dividing it by the maximum heart rate (HRmax). Statistical verification was performed by performing an independent t test by using SPSS 19.0 (IBM, Armonk, NY, USA). Statistical significance was set at $P < 0.05$. The resting heart rate in the non-smoker and smoker groups were 72.4 ± 5 and 80.1 ± 5.8 bpm, indicating a significant difference ($t = -5.205$, $P < 0.001$). However, no significant difference in maximum heart rate was observed. In the non-smoker and smoker groups, the VO_2max values according to smoking status were 57.3 ± 6.4 and 56.8 ± 4.2 mL·kg·min, respectively, without significant difference between the groups. The heart rate reduction rate at HRR was 4.46 ± 2.2 % in the non-smoker group and 2.4 ± 2.1 % in the smoker group, with significant difference between the groups (t =

2.827, P = 0.007). At HRR, the rates were 10 ± 4.4 % and 6.72 ± 1.8 %, respectively, with a significant difference between the groups (t = 3.335, P = 0.002). Similarly, at HRR, the rates were 15.2 ± 6.4 % and 10.9 % ± 2.7%, respectively, confirming a significant reduction rate (t = 3.027, P = 0.004). Finally, at HRR, the heart rate reduction rates were 18.6 ± 6.9 % and 14 ± 2.2 %, respectively, showing a significant difference (t = 3.216, P = 0.003). Our results show that even if the maximum exercise capacity of the young healthy persons who regularly exercised was not affected by smoking, their HRR after exercise was still delayed. Moreover, they strongly suggest that even with regular exercise, the prevalence of coronary artery disease is still higher among smokers than among non-smokers.

Garcia-Aymerich, et al., (2007) estimated the longitudinal association between regular physical activity and FEV1 and FVC decline and COPD risk. A population-based sample (n = 6,790) was recruited and assessed with respect to physical activity, smoking, lung function, and other covariates, in Copenhagen in 1981–1983, and followed until 1991–1994. Mean level of physical activity between baseline and follow-up was classified into “low,” “moderate,” and “high.” FEV1 and FVC decline rates were expressed as milliliters per year. COPD was defined as FEV1/FVC ⩽ 70%. Adjusted associations between physical activity and FEV1 and FVC decline, and COPD incidence, were obtained using linear and logistic regression, respectively. Active smokers with moderate and high physical activity

had a reduced FEV1 and FVC decline compared with those with low physical activity (relative change of +2.6 and +4.8 ml/yr of FEV1, P-for-trend = 0.006, and +2.6 and +7.7 ml/yr of FVC, P-for-trend < 0.0001, for the moderate and high physical activity group, respectively), after adjusting for all potential confounders and risk factors of lung function decline. Active smokers with moderate to high physical activity had a reduced risk of developing COPD as compared with the low physical activity group (odds ratio, 0.77; p = 0.027). This prospective study shows that moderate to high levels of regular physical activity are associated with reduced lung function decline and COPD risk among smokers.

Dianna Louie, (2001) studied peak expiratory flow was measured as an indicator of lung function, expired carbon monoxide level was measured as an indicator of current smoking and the associated reduction in the oxygen carrying capacity of the blood, and blood pressure and heart rate were measured as indicators of cardiovascular hemodynamics before and after a one-mile run in 27 teenagers. The results show that, even at a young age, cigarette smoking is associated with significant detrimental effects on cardiopulmonary function and exercise tolerance. Objective evidence of an effect of smoking on cardiopulmonary function and exercise tolerance in this age group may assist educators and health care professionals in convincing teenagers to quit smoking.

2.4. SUMMARY OF RELATED LITERATURE

The studies reviewed illustrate that there are many smokers and nonsmokers, musculoskeletal, cardiopulmonary, submaximal and maximal training for varied population. These studies show that regardless of current fitness status, interventions can be successful in improving the fitness and wellness status of a variety of individuals. The results are encouraging as they know the status of their ability to improve overall physical health and mental wellbeing which may be considered as a prime importance of smokers.

It was also observed from the review of literature that there is no research studies related to present study in analyzing selected variables which are contributed to the current fitness status. This inference has motivated the researcher to undertake this study.

The review of literature helped the researcher from the methodological point of view too. It was learnt that most of the research studies cited in this chapter on content analysis and experimental design as the appropriate methods for finding out the lapses and remediation.